**Toward More Inclusive Science: New Challenges and Responsibilities for Scientists, Philosophers, and Citizens**

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## 1. Introduction

Once upon a time, science was widely held to be, and advocated as a key source of progress in most if not all dimensions of our lives. In order to vindicate sustaining massive public investment in science after the close of World War II, Vannevar Bush, chief scientific advisor to President Roosevelt who played a key role in American science policy at that time, made it very clear in his seminal science policy treatise "Science - The Endless Frontier" that "Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress" (1945, p. 2). This centrality of science and innovation has only intensified since Bush's time and cannot be overstated today. More than ever, science retains its role as the main engine of economic growth and a key contributor to most other areas of activity in societies. For instance, behind recent, massive governmental support for the development of quantum engineering lie major challenges of national strategic independence. And, of course, the COVID-19 crisis has vividly reminded us of our direct dependence on science not only for preventing or curing diseases, but also because nowadays many political decisions directly shaping our daily lives are based on scientific expertise.

In short, scientific development impacts our lives, directly or indirectly, to unprecedented degrees. Admittedly, while the works of Newton or Darwin radically altered the physics and biology of their times, they had much less impact on the lives of their lay contemporaries. Today, however, the widely acknowledged centrality of science is associated with more differentiated attitudes toward the impact of science on society. Surveys of public opinion about science suggest that over the past fifty years or so, trust in researchers has remained, globally, very high compared to other professional categories, but a strong, unconditional deference to science has progressively given way to more conditional support: the idea that science brings benefits to humanity is no longer taken for granted over the whole range of scientific disciplines. More people now hold that "science does as much harm as good" rather than "science does moregood than harm" (Boy and Rouban 2019).[1] Interestingly, some surveys suggest that these different attitudes toward science go hand in hand with an increasing demand for the involvement of lay citizens[2] in the choices and decisions shaping scientific development. This should come as no surprise. When many dimensions of one's daily life are impacted by scientific developments that are not necessarily deemed beneficial, one may indeed want to have a say in these choices.

In light of these changes, my general aim in this chapter is to investigate the prospects of a more inclusive science to better fulfill humanist expectations. In other words, to what extent and under which conditions would involving lay citizens in the scientific enterprise increase the relevance and benefits of its outputs to society? My take on the notion of humanist expectations towards science will be rather straightforward: expecting science to bring progress and human flourishing mainly means expecting that the outputs of research and innovation are well aligned with the various needs and interests of the citizens of a society at a given time of its history.

Public engagement with science comes in many shades, depending on the nature of the engagement and the phase of scientific inquiry at which it occurs. Central to the purpose of this chapter is the discussion the phase of choice of research questions and priorities, since reducing the gap between what science delivers and what society needs depends directly on the way the agenda of research and innovation is set. I will thus start with a brief description of how research priorities are defined in most "research intensive" countries and explain why it is hardly surprising that this gap exists between the outputs of scientific inquiries and society's needs. To set the stage for the discussion of the prospects of a more inclusive science to reduce this gap, I will present the many faces of citizens' involvement with science as well as relevant background features of our "participative societies". The bulk of the chapter will examine, for various types of public engagement, the potential benefits of a more inclusive science, but also epistemological, cultural tensions and sticking points potentially thwarting its humanist prospects. I will discuss in particular new responsibilities and challenges for

[1] The situation may vary from one country to another but the general trend toward a more differentiated attitude is shared among many European countries.

[2] The use of the term 'citizen' in the context of a discussion of citizen science may raise exclusionary concerns. For the fact is that not all members of society affected by scientific developments have citizenship. My use of the term 'citizen' in this chapter includes these members.

scientists, including new expectations regarding professional training and the ethics of research.

## 2. Setting the research agenda: current systems of governance of science and their limits

Who are the main actors today involved in the setting of research agendas? The answer may of course vary to some extent from one country to another, but sociological studies of science organization identify common, dominant features (e.g., Gläser and Velarde 2018). There exist in most "research-intensive" countries national agencies directly involved in the shaping of the research agenda or coordinating strategic committees. Just to name a few, Japan and the United Kingdom each have a "Council for Science and Technology Policy", The United States has its "National Science and Technology Council", Switzerland its *Conseil suisse de la recherche* (Swiss council for research), etc. In France, the *Conseil stratégique de la recherche* (Strategic Research Council) is explicitly in charge of "identifying and proposing a limited number of big research and technological priorities to prepare and construct the future of France." Who, you may ask as a citizen eager to find out who decides the public research priorities of your country, serves on this council? Not surprisingly, the majority comprises very distinguished French scientists (mostly from the natural sciences), a few representatives of big French companies, and three elected representatives.[3] The composition of the French Research Strategic Council illustrates the dominant players in the field in most countries: scientists, representatives of the private sector interests (the market, in short), and politicians. Looking into further details would reveal a complex interplay between these actors. But what matters for our purpose is assessing to what extent those actors are the right ones to fulfill the humanist expectation of a better alignment between what society needs and what scientific research delivers.

Two preliminary qualifications are in order here. The first spells out a key background philosophical commitment of the rest of the chapter; the second is essentially conceptual and terminological.

First, my take on the notion of humanist expectation toward science will be non-objectivist, that is, the very notions of "human flourishing" or "common good", etc. that a humanist science would help to promote should be approached in a non-objectivist way. In

[3] https://fr.wikipedia.org/wiki/Conseil_strat%C3%A9gique_de_la_recherche Accessed April 12, 2023.

other words, I will be committed to the idea that the outputs of a humanist science, in the context of our democratic societies, should contribute to meet the needs and interests of their citizens, *as identified and expressed by them*.[4] This non-objectivist approach can be contrasted with an objectivist, substantialist approach, according to which the citizens' needs and interests to which science should respond can be defined independently (or partly independently) of what citizens themselves would identify and express as being their needs and interests. Later developments (in section 3) on our increasingly participative societies will buttress this commitment.

The second qualification concerns the nature of the problems addressed by science: a distinction will be made between "endogenous" problems and "exogenous" problems (Bedessem and Ruphy 2019, p. 2). An "endogenous" problem is encountered and defined internally by scientists within the course of a scientific inquiry, and its relevance and interest are judged solely according to epistemic or practical considerations internal to scientific communities. By contrast, an "exogenous" problem is identified outside (or partly outside) a scientific field and evaluating its relevance and interest incorporates interests and needs of other components of society (and not only of scientific communities). "Grand societal challenges" such as developing "secure, clean and efficient energy" or "inclusive, innovative and reflective societies"[5] are typical exogenous (encompassing) problems whereas the search of the Higgs boson in particle physics is a rather newsworthy example of endogenous problem. With these two qualifications in hand, let us now return to the question of who sets, or should set, scientific research agendas.

*The scientists (Epistemic elitism)*

Let us start with the prospects of "epistemic elitism", as Kitcher puts it, to refer to the idea that "the wise experts can be expected to know what's objectively in human interests" (Kitcher 2001, p. 138). Are scientists today in the best position to define research priorities fulfilling humanist expectations? There are several reasons to seriously doubt it. Sarewitz (2016) for instance points out that the current functioning and internal reward systems of

[4] I follow here for instance Kitcher's non-objectivism when he elaborates his ideal of well-ordered science (Kitcher 2001). By contrast Kourany's plea for a research guided by "sound social values" partakes of an objectivist approach (Kourany 2010).
[5] These two examples are drawn from the Horizon 2020 program put forward by the European Commission.

scientific communities do not spontaneously favor the orientation of scientific agendas towards the resolution of exogenous problems. Career enhancing drives (publishing papers in highly ranked journals, Nobel prizes and the like) in particular may even pull in the other direction: producing more esoteric knowledge, valued first and foremost by your peers, without much consideration of direct usefulness for society. As Sarewitz puts it, not mincing his words, “Advancing according to its own logic, much of science has lost sight of the better world it is supposed to help create. Shielded from accountability to anything outside itself, the “free play of free intellects” begins to seem like little more than a cover for indifference and irresponsibility” (2016, p. 40). Independently of this lack of an internal propensity to address exogenous problems, epistemic elitism can be challenged on the more fundamental and simple ground that epistemic expertise in a particular field of research does not guarantee relevant epistemic expertise when it comes to grasping which exogenous problems should be addressed first and foremost to fulfill the needs and expectations of a society as it exists at a certain point in its history. When they aim at finding out what people think or need, the human and social sciences might, admittedly, help to provide this kind of expertise, but the fact is that they are currently only very marginally involved in the setting of big research priorities.

*The market*

On the face of it, the prospects of relying on the private sector might seem a bit better. After all, in societies with market-driven economies, doesn’t a market-driven science respond to *some* needs and interests of the citizens of these societies? Answering this question would take us back to more general political considerations. In particular, the extent to which a market economy can meet the needs and interests of society is notoriously non-consensual, depending on your political preferences. In any case, it seems safe to contend that if solely shaped by economic interests (be it directly through private sector actors or indirectly through public-private agreements), the research agenda would not be responsive to the *whole* range of needs and interests of society, but only to a limited (albeit central in our capitalist societies) subset of it. What would evidently not be addressed are public interests that do not intersect with those of the private sector, as rightly emphasized by a large critical literature on the “commercialization” or “commodification” of science (e.g. Radder 2019).

*Elected representatives*

Here is where, one could hope, our elected representatives could step in to make sure that public interests are sufficiently served as well, or even solely (depending on your political inclinations) served by publicly funded research. After all, aren't elected representatives supposed to act on the *whole* range of interests and needs of their constituents? Well, their capacity to do so is notoriously questioned in our contemporary democratic societies. I will outline later general considerations that shed light on the diminishing appreciation by citizens of representative forms of democracy. Let us just note for the moment that biases toward short-term, practical goals, collusion with private-sector actors, etc., are often mentioned as grounds for resisting a direct shaping of the research agenda by politicians.

*Responsible research*

In light of the previous remarks, the existence of a gap between what science actually delivers and citizens' needs and interests should come as no surprise. A couple of years ago, an editorial in the influential scientific journal *Nature* (2017), entitled "Beyond the science bubble", made it very clear: "the needs of millions of people in the United States (and billions of people around the world) are not well enough served by the agenda and interests that drive much of modern science". The Human Genome Project is taken as an example of a successful scientific story but with mixed impacts on society. In addition to new insights in genomics, it did create firms and jobs, but "rather than trickling down through society, these benefits of discovery science arguably deepen the pool of wealth and privilege already in place – creating expensive new drugs that most people cannot afford." And the editorial concluded with a plea for more social responsibility: "science organizations – universities, funders, supporters and the rest – should look harder at social problems and opportunities and seek ways for science to help."

This piece in *Nature* is one example among many of the expression of a growing demand for more accountability and social responsibility from research actors. On the institutional side, this demand is reflected, for instance, in the notion of "Responsible Research and Innovation" (RRI) put forward by the European Commission, aiming at fostering "the design of inclusive and sustainable research and innovation". But how should this social responsibility be exercised when epistemic elitism is no longer, at least from a normative point of view, a live option? Direct public participation has become the favourite answer of a growing number of scientific institutions and governing bodies. Through its appeal to Responsible Research and Innovation, the European Commission, for instance, promotes it explicitly: "societal actors (researchers, *citizens*, policy makers, business, third sector organizations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society" (my italics).

Before assessing its prospects, let me put public participation in science in the broader perspective of an increasing demand for more direct participation by citizens in various areas of public and political life, starting with a few examples.

**3. Participative societies**

In election campaigns for example, citizens are sometimes directly consulted by a party to build up its political priorities. Some mayors reserve parts of municipal budgets to be spent according to priorities defined by public consultation. More sophisticated and deliberative forms of citizen consultation are set up to feed into the elaboration of national plans by governments or assemblies. A noticeable recent example is the Citizens Convention for Climate set up in France by President Macron.[6] Such participative forms of democracy are often presented by democracy theorists as a means to redressing the weakening of traditional representative forms of democracy, both at national and local levels.

More broadly, direct participation of citizens may be considered an appropriate response to the following six changes in contemporary democratic societies (Blondiaux 2008, pp. 24-28, my translation): (i) *Increasingly complex societies*. Our societies are more and more divided into specialized "sub-systems" calling for the existence of distinct spaces of negotiation and governance; direct participation of citizens in these governance processes may serve to meet democratic expectations. (ii) *Increasingly divided societies*. Here, the focus is more philosophical than sociological. Our pluralist democratic societies are characterized by divergent views on what is good or bad, without the ability to directly overcome these differences by referring to common values or principles. Hence the necessity to implement spaces for deliberation where citizens can justify their disagreements and work on reaching consensus. (iii) *Increasingly reflexive societies*. Overall levels of knowledge and proficiency of

[6] https://en.wikipedia.org/wiki/Citizens_Convention_for_Climate Accessed April 10: 2023.

lay citizens have increased. At the individual level, deference to experts is not unconditional and lay or experiential knowledge can be put forward as a counterpoint or as an addition to certified knowledge provided by scientific institutions. Standpoints of lay citizens can then be expected to be taken into account in decision processes. (iv) *Increasingly disobedient societies*. In response to individual or local acts of insubordination, often linked to health or environmental issues, citizens' consultations appear as a means to prevent or diffuse such resistance, sometimes labeled in a somewhat derogatory way as the NIMBY (Not in My Backyard) syndrome. (v) *Increasingly defiant societies*. A decline in confidence in institutions and between citizens has been extensively described and discussed by sociologists. Direct participation of citizens may be promoted, especially at local scales, as a means to recreate social ties. (vi) *Increasingly ungovernable societies*. The preceding five changes feed into a final one: in many liberal democracies, states and political decision makers appear more and more powerless to impose decisions from the top downwards.

Blondiaux's six propositions, built on various seminal works by sociologists and philosophers such as John Rawls, Jürgen Habermas, Ulrich Beck, and Niklas Luhmann, allow us to make sense of the significant development of participatory devices in many areas of public and political life: In order to cope with this crisis of governability, governing bodies see the development of various mechanisms for citizen participation as a mean to increase their political power of action. And science is, or should be, no exception to this general trend toward more direct involvement of citizens, given its centrality in our societies and the multiple levels of imbrication between science, public life, and politics. This non-derogating status of science partly explains my earlier commitment to non-objectivism: in more participative societies, when it comes to defining their needs and interests in terms of research outputs, citizens should be directly involved.

Let me now briefly describe the various forms that public engagement may take in science.

## 4. The many faces of citizens' engagement in science

### *Non-participative forms of engagement*

A minimal, traditional form of involvement with science is exemplified in the public understanding of science. The associated notion of 'science literacy' has become a multifaceted notion, reflecting various, growing demands of mastering developments in scientific knowledge. Given the centrality of science in our daily lives, science literacy is commonly promoted as essential to "help people live interesting, responsible, and productive lives" (American Association for the Advancement of Science, 1994, p. XI). In this traditional approach, citizens remain passive receptors of scientific knowledge or, in more recent takes on the notion of scientific literacy, passive receptors of knowledge about science as a social enterprise (Slater et al. 2019), without any direct participation in the process of knowledge production itself.

At the other end of the spectrum lies another long-standing and multi-faced form of engagement with science, to wit, public contestations of science.[7] In that case too, lay citizens remain outside the process of knowledge production.

*Participative forms of engagement*

The current diversity of participative forms of involvement with science, where non-professional inquirers are involved in the very process of knowledge production, has given rise to a variety of classifications. Following the commonly-used classification proposed by Bonney et al. (2009), my discussion will distinguish between "contributory", "collaborative", and "co-created" science.

In the first kind of participatory practice, *contributory science*, involvement of non-professionals is limited to the phase of data collection: citizens act as passive or active data collectors and are not involved in the phase of defining the problems to be solved or in the phase of interpreting and producing the results. Such crowdsourcing programs, in which any interested citizen can participate, constitute the most widespread type of participatory practices and have a long history in fields such as astronomy and environmental sciences. *Collaborative science* corresponds to a stronger form of engagement of specific populations identified by scientists as sharing expertise or skills. In agronomic research, for instance, programs in plant breeding take advantage of the practical knowledge of farmers to improve productivity. In biomedicine, the experiential knowledge of groups of patients is now commonly considered a key ingredient in the success of the development of a treatment.

[7] An often cited historical example is the nineteenth-century protest by the Luddites in England against textile machinery and, more broadly, against the impacts of scientific and technological developments on the quality of human lives.

Participation thus goes well beyond data collection: non-professionals can also be involved in the design of methods and the interpretation of results. In *co-created science*, by contrast with contributory and collaborative science, the initial formulation of the problem to be solved is not made by scientists but by citizens, who in this case are better described as stakeholders.[8] This corresponds to a stronger form of participation: to resolve problems that stakeholders have themselves identified, scientists collaborate with them at every stage of the scientific process, from the co-construction of the initial problem as a research question to the collection and interpretation of data and the production and diffusion of results. "Community-based research" is another common label for this strongest form of engagement, reflecting the *local* character of the problems to be solved when, for instance, a group of people faces an environmental risk such as the pollution of a lake, or is affected by a rare genetic disease.

Admittedly, even taken together, these three participative forms of scientific inquiry still represent today only a very small fraction of global scientific knowledge production. However, in several research fields with direct societal impact such as the environmental sciences and biomedical sciences, they occupy a more central stage and are increasingly supported by research institutions.

*Participation in the setting of global research priorities*

The last kind of citizens' involvement I will consider here is the participation of lay citizens in decision processes concerning *global* research priorities, that is, research priorities affecting *all* citizens. In contrast with the previous forms of citizens' involvement, this form of involvement remains largely programmatic. As briefly described in section 2, current systems of governance of science do not include mechanisms for citizen participation - or when they do the actual participation of citizens remains anecdotal. Sure enough, various types of participatory mechanisms have been set up to consult citizens on specific issues in the domain of science and technology (e.g. nanotechnology), such as the pioneering "consensus conferences" organized by The Danish Board of Technology in the late 1980's. However, existing participatory mechanisms are very rarely designed to address the broader issue of what the big priorities of science in response to the society's needs and interests should be.

[8] Following the literature on public deliberation (Kahane and Lopston 2013), 'stakeholders' refers here to a group of people who is directly affected by a problem or by the various ways it may be resolved.

That is where philosophers might step in, proposing ideals of democratization of the research agenda. For example, the ideal of 'well-ordered science' developed by Philip Kitcher (2001) has been widely discussed in the philosophy of science. In a nutshell, in well-ordered science, the problems addressed by scientists are those selected by a group of deliberators, tutored by scientific experts, who dedicate themselves to revising their preferences in light of the preferences of others (Kitcher 2001, chap 10).

**5. Assessment of the humanist prospects of public engagement in science**

To assess the prospects of a more inclusive science as regards the reduction of the gap between science's outputs and society's needs, after some quick comments on non-participative forms of engagement, I will then discuss forms of participation that do not impact scientific life globally, and turn to the assessment of participation in the setting of global research priorities in the next section.

*Public understanding of science and contributory science*

The humanist prospects of non-participative forms of citizen involvement such as the public understanding of science have been well identified for a long time. Having some cognitive access to our most important scientific insights into the world is consensually held to contribute toward having a meaningful life for at least three reasons (Shen 1975): 'practical science literacy' helps people to make individual decisions in their everyday lives; 'cultural science literacy' helps people to appreciate scientific achievements, and 'civic science literacy' allows people to reach considered decisions about issues that have scientific components.

When participation is limited to the collection of data as in the case of contributory science, the humanist prospects of citizens' involvement are in the same vein. For one can reasonably expect increased science literacy in the three previously mentioned dimensions from citizens involved in scientific inquiry as data collectors. But what about the prospects of greater science literacy when one adopts the deflationary approach to the notion of humanist expectations advocated above? Otherwise put, to what extent may increase science literacy help to reduce the gap between what science delivers and what society expects and needs from science? By itself, greater science literacy won't help to bridge the gap as long as the decision processes establishing global science policies are not open to lay citizens. Nonetheless, it seems reasonable to think that science literacy should at least raise general awareness of the centrality of science in our societies and, consequently, of the necessity to democratize the setting of its research agenda. Lacking conclusive empirical studies of such correlations, let me move to the prospects of the second type of participation, to wit, collaborative science.

*Collaborative science*

In the case of collaborative research, the epistemic benefits brought about by involving a lay population with specific skills or experiential knowledge in scientific inquiry are better known (e.g. Bedessem and Ruphy 2020). A paradigmatic and well-documented case of successful contributions of lay expertise is the contribution of AIDS patients to research aiming at understanding and curing the disease (Epstein 1995, Godlee 2016). Here, the benefits went beyond epistemic gains: it also brought about more *actionable* scientific findings, that is, scientific findings more easily translatable into therapeuthic care well adapted to the specificities of living with this new disease, as documented by the AIDS patients themselves. Collaborative research programs in agronomy also illustrate this benefit of more actionable findings: involving farmers having experiential knowledge of a particular local context allows for the production of knowledge and recommendations well adapted to that context, and is hence more useful to the population concerned. By allowing the production of more actionable findings, a more inclusive science in the sense of collaborative science thus allows for more directly relevant and useful outputs, thereby contributing to the reduction of the gap between what science delivers and what people need. Conditions of success in fulfilling humanist expectations towards science thus correspond to conditions of success in collaborative science.[9] Let me just mention here that a key factor of successful collaborative science is the ability of professional researchers to communicate and interact with non-professionals. This is certainly still a cultural and professional challenge for scientific communities since these kinds of interactive skills are very rarely part of the regular training of future scientists (remember that "among peers" has been the rule for a long time in science: peer evaluation in particular playing a central role in many phases of scientific endeavour).

[9] Those conditions are discussed more extensively in Bedessem and Ruphy (2020).

*Co-created science (community-based research)*

As regards the question of reducing the gap between the outputs of scientific inquiry and the needs and interests of citizens, the answer is even more straightforward for community-based research. In this case, since the problems to be addressed are identified by the stakeholders themselves, the issue is moot: research programs are conceived from the beginning to contribute directly to respond to the needs and interests of concerned group of citizens. However, opening the very process of the production of knowledge to stakeholders gives rise to various epistemological and political challenges.

Let us consider first an epistemological risk (discussed in more detail in Bedessem and Ruphy (2020)). When research programs are developed mainly by local communities to contribute toward solving specific problems they are facing (hence exogenous problems for scientific communities), this may lead to a fragmentation of the research agenda overall into a juxtaposition of unrelated research questions needing to be resolved in isolation. From a purely epistemological point of view, such fragmentation may be deemed problematic for the overall dynamics of the research fields concerned. The reason is, in short, the following: when exogenous problems are chosen in light of their urgency from a political or practical point of view, rather than in light of their potential epistemic interest for the development of a research field, the resolutions of these problems are unlikely to open new lines of inquiry that will increase fundamental knowledge in the research fields concerned. [10] Moreover, the kind of research questions addressed in co-created research science may not be cutting-edge questions, and therefore may not be very attractive for professional scientists. In any case, the key normative question is whether epistemological considerations should prevail when it comes to valorizing one type of research over another. I suggest that it should not. Defending an utilitarian view of science today – as Vanevar Bush did 80 years ago – requires that we valorize equally the work of scientists engaging in community-based research. Sure enough, it is up to researchers to decide to engage in co-created research or in blue sky, basic research (or in both for that matter): at the end of the day, it is a matter of personal, political, and ethical choice. However, as briefly mentioned in section 2, the current internal reward system of scientific communities does not really encourage scientists to work alongside with

[10] This line of argument is only valid for exogenous problems in the specific context of co-created science. In other contexts, see Bedessem and Ruphy (2019) on the epistemologically positive impact on the dynamics of a research field of addressing exogenous problems.

communities and stakeholders to contribute toward solving practical problems defined by the latter. And as in the case of contributory science, changes in the training of scientists (or a subset of them) is also called for to facilitate interactivity with non-professionals. Overall, beyond financial support, more incentives to engage in inclusive research are needed from scientific institutions and scientific communities.

Another challenge results from a *prima facie* tension between the inclusion of stakeholders in scientific research and traditional expectations of objectivity and impartiality, since in co-created research, the very questions being asked are chosen in relation to the stakeholders' interests. Two levels of concern should be distinguished here. First, one may worry that when inquirers have stakes in the output of the inquiry, they might be tempted to take some liberties with the usual standards of good practice which guaranty the reliability of the results, in order to channel them toward what they consider as desirable conclusions. The concern is understandable but calls for more empirical study. Departures from standards of research integrity are already notoriously difficult to document within traditional scientific communities. More work needs to be done to find out whether this concern is more serious in the case of community-based research.[11]

Meanwhile, let us discuss the second level of concern, which takes us to the political issue of unbalanced processes of production of scientific expertise (Sarewitz 2004; van der Vegt 2018).[12] Consider the production of expertise on a multi-faceted issue such as, for example, an environmental or health security issue, for which various co-created research programs are developed, each aiming at addressing a limited dimension of the issue, in relation to the interests of the stakeholders involved. Depending on the play of power between stakeholders, you might end up with biased scientific expertise on the issue *overall* (even if the expertise developed in each individual program is not biased at all), because some aspects of the issue may remain understudied. Biddle (2018) offers a detailed analysis of this phenomenon in the case of genetically modified organisms (GMO). To sum up the basic idea: the food industry favours the production of expertise on yield increase, whereas anti-GMO

[11] As discussed in Bedessem and Ruphy (2020, p. 641), interestingly, some studies (e.g. Yamamoto 2012) suggest that as stakeholders, participants may pay more attention to the existence of potential conflicts of interest in professional scientists, thereby perhaps attenuating the risk of diminished objectivity and impartiality. In any case, it is not (yet) unnecessary to remind ourselves that awareness and prevention in the domain of research integrity is needed for any type of research.

[12] The point is discussed in more detail in Bedessem and Ruphy (2020, 642).

NGOs favour the study of environmental impacts. In light of these considerations, what can be expected from decision makers, scientific institutions, and also individual scientists? Decision makers, together with scientific institutions, especially public ones, should make sure that no aspect of the issue is understudied so that they can act on the basis of unbiased expertise (overall). This requires that public scientific institutions and funding agencies in particular should favour research on topics that tend to be understudied, in order to compensate for the effects of unbalanced power. For what matters for a functioning democracy is that when decisions have to be made based on scientific expertise, there are no blind spots in the expertise available. Regarding individual scientists, it seems reasonable to expect that they should show their hands, by being transparent about the roles they choose to play when producing (reliable) knowledge of a limited aspect of a phenomenon, in relation to their own values and interests. In other words, being an "Issue Advocate", to follow Pielke's (2007) terminology[13], is perfectly acceptable, both epistemologically and politically.

The discussion so far has focused on assessing the prospects of opening the process of producing knowledge and expertise to better respond to *local* needs and interests. Let us turn now to a more overarching, global perspective on the setting of the research agenda.

## 6. Assessment of participatory devices in the setting of *global r*esearch priorities

Directly involving citizens in the setting of *global* research priorities is, admittedly, at least on paper (and if we opt for non-objectivism), the best way to reduce the gap between the actual needs and interests of all citizens and the needs and interests that are currently shaping research agendas. Let us now investigate the various, possible impacts that such direct participation would have on scientific life and the consequent new responsibilities for researchers and scientific institutions, leaving aside the multifaceted and thorny issue of how a direct shaping of the global research agenda by citizens could concretely be implemented.[14]

[13] Pielke (2017) proposes a typology of four idealized roles for scientists engaging in decision making: the "Pure Scientist", the "Science Arbiter", the "Issue Advocate", and the "Honest Broker of Policy Alternative". When acting as an Issue Advocate, a scientist "focuses on the implications of research for a particular political agenda. Unlike the Pure Scientist, the Issue Advocate aligns him/herself with a group (a faction) seeking to advance its interests through policy and politics" (2017, p. 15).

[14] In other words, let us set aside the (in principle) multiple shortcomings of and difficulties encountered by participatory processes at global scales. Recall (section 2 of this paper) that effective participatory processes in the setting of global research priorities have not yet been implemented in real life.

This discussion will be structured around the identification of three tensions or sticking points, starting with issues of the legitimacy of the very demand for social responsibility that underlies humanist expectations toward science.

*Legitimacy of the demand for accountability*

I emphasized earlier a growing demand for social responsibility and accountability in the sense of being directly useful to society. This demand could be rejected on the simple grounds that direct social utility is just not a legitimate demand on science, contra currently predominant institutional, science policy discourses and philosophical views (e.g. Kitcher 2001, 2011, Kourany 2012, Radder 2019). This rejection position is still endorsed by some influential practising scientists, usually as part of a plea for more money for blue sky research. In 2014, Sir J. Cadogan, a well-known British chemist, and 41 other Fellows of the Royal Society, expressed very clearly their reluctance to address societal challenges:

> "The nature of all politics and politicians means it is easier for our pay-masters to feel comfortable about the proclaiming of programmes relating to Energy, Health, Materials, Climate Change, the Hydrogen Economy and so on, rather than to announce, let alone trumpet, that money is available for scientists to follow their curiosity in their own disciplines." (Cadogan 2014)

This resistance to direct social utility is hardly something new. In 1955, the famous physicist Richard Feynman expressed similar concerns with the shaping of the research agenda to fulfil societal needs, but on the slightly different grounds that scientists are just not good at solving societal problems:

> "From time to time, people suggest to me that scientists ought to give more consideration to social problems – especially that they should be more responsible in considering the impact of science upon society … And it seems to be generally believed that if scientists would only look at these very difficult social problems and not spend so much time fooling with less vital scientific ones, great success would come of it.
> It seems to me that we do think about these problems from time to time, but we don't put full-time effort on them – the reason being that we know we don't have any magic formula for solving problems, that social problems are very much harder than scientific ones, and that we usually don't get anywhere when we do think about them." (1955, p. 13)

Cadogan's and Feynman's standpoints sum up two views on the very nature of scientific research that are culturally still very entrenched in scientific communities and beyond. First, curiosity and the urge to discover the secrets of Nature are widely held as the most central motivation for engaging in scientific inquiry. Therefore, scientists should be left free to follow their curiosity when inquiring about the world (rather than being expected to solve societal problems), all the more because they are more successful when doing so. And this takes us to the second view, which is about comparative success in solving problems, depending on whether the problem is defined internally by scientists – endogenous problems in our terminology, or in light of considerations external (or at least partly external) to the inner dynamics of a scientific field (i.e., exogeneous problems).

The bottom line of a Feynman-type reluctance to accept the idea of socially responsible science is that scientists are more successful when addressing endogenous problems than when addressing exogenous ones. Kuhn's (1962) defence of the social irrelevance of research problems on resolution efficiency grounds is in the same vein. From an epistemological point of view, it would be hard to deny that addressing exogenous problems raises the additional challenge of translating social issues into tractable research problems and may very well diminish efficiency and success of scientific inquiry. But, again, should epistemological considerations prevail when it comes to the shaping of the research agenda? This question can be addressed as part of the broader, fundamental question of who should decide what the very aims of science should be.

It is now commonly acknowledged that the pursuit of exogenous problems has become more prevalent in the past few decades. Seminal contributions from science and technology studies (STS) have extensively studied this trend, describing in particular the evolution of modes of research funding and the setting of research priorities. For instance, Etzkowitz (2003) proposed the concept of a triple helix of entrepreneurial science to describe the intertwining of government, industry, and academia. The much discussed contrast between 'mode-1' and 'mode-2' proposed by Gibbons et al. (1994) emphasized a shift from a traditional academic, discipline-based mode of production of knowledge toward a more interdisciplinary, application-oriented one.

In another paper (Ruphy 2019), I proposed that we reformulate our understanding of these changes in terms of a shift towards more pressing and targeted expectations. When Vannevar Bush advocated massive public support of science on utilitarian grounds, he advocated at the same time complete scientific freedom as regards the setting of research agendas: "Scientific progress on a broad front results from the free interplay of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown. Freedom of inquiry must be preserved under any plan for government support of science" (Bush 1945, 12). This suggested connection between utilitarian expectations toward science and freedom of research topics followed from what is often called the "cascade" model of the relationship between science and society (e. g., Guston 2000). In this model, society, via its governing bodies, gives "blind delegation" (Wilholt and Glimell 2011) to research communities to conduct their business. In particular, policies of research oversight and funding are limited, in order to inject money into scientific communities without setting any thematic priorities. According to this model, often considered a lost paradise by many scientists, the main aim of researchers is to fill a reservoir of knowledge, following their curiosity, and from this reservoir of knowledge will eventually emerge in short or long terms – who knows, research being unpredictable – all kinds of things beneficial to society, especially technological innovations. Researchers in public institutions know all too well that we have significantly departed from this cascade model.[15] How should we make sense of this transformation?

A possible reading of the decline of the cascade model is, I suggest, properly understood in terms of an evolution of our expectations of science. We no longer expect more knowledge and more innovation *tout court*, but more knowledge and more innovation in specific priority domains, corresponding to specific needs, and sometimes urgently so, in light of challenges encountered by our societies (climate change, an aging population, etc., you name it). In this previous paper (Ruphy 2019), I proposed that we consider this shift toward more pressing and more targeted expectations as the other side of the coin of the very success of science and innovation in our knowledge societies. As soon as science becomes a key element of so many aspects of the development of our societies, it is understandable that expectations from other components of society, including of course public science funders, should become increasingly pressing and specific. Otherwise put, there is a shift from an "offer mode" towards a "demand mode". In the former, scientific inquiries are mainly oriented by endogenous problems and produce new knowledge that, in turn, may lead to very useful exogenous developments. The development of the now ubiquitous laser is a paradigmatic

[15] This departure is well documented, for instance, in Guston (2000). It is also emphasized in the *Nature* editorial mentioned earlier: "Just telling the same old stories won't cut it. The most seductive of these stories – and certainly the one that scientists like to tell themselves and each other – is the simple narrative that investment in research feeds innovation and promotes economic growth" (*Nature* 2017).

success story of this view of science as filling a reservoir of knowledge for later applications. By contrast, in the "demand" mode, scientific inquiries are mainly oriented by exogenous problems – say, the demand for a cure for a new virus-borne illness, or the need for strategic independence in cryptography.

The key, normative philosophical question is then the following: is this shift towards more targeted and pressing expectations legitimate and desirable, or should it be resisted and if so, on what grounds? This question takes us back to the question with which I began: who should decide what the very aims of science are or should be in our societies?

Philosophers of science are traditionally very good at discussing what the *epistemic* goals of science are or should be: discovering the laws of nature, providing objective explanations, for instance by making use of causal patterns (Potochnik 2017), etc. But should these epistemic aims be ends in themselves or just instrumental to practical ends? The traditional contrast here is between (in short) a primarily epistemic view or a primarily utilitarian view of the aims of science. Which one is the right view? I contend that the answer to this fundamental question should be *political*. In a democratic society, where research is (at least in part) funded by public money and plays such a central role in so many aspects of life, it should not be up to scientists (or for that matter philosophers) to decide what the very aims and value of science are or should be. We should thus avoid any essentialist approach to thinking about these aims, and prefer instead a thoroughly political one. In other words, the question of which of the two traditional views of the aims and value of science should prevail is an open, political question; it should not be decided by invoking some putative essence of what science is about. Acknowledging this is certainly in tension with well-entrenched cultural views of science, widespread both in scientific communities and in the rest of the society. But it is a necessary preliminary step toward addressing the question of the legitimacy of the demands for accountability and social relevance. As I have just stated that invoking some putative essence of science is not an option to decide what the aims and value of science are, it is also not an option for rejecting such a demand. So let us now question two other sources of resistance to accountability.

*Tension between accountability and unpredictability*

A second interesting source of resistance to more accountability in the sense of direct social utility invokes a tension between accountability and a central feature of scientific inquiry, namely its unpredictability. To put it very simply: how can one expect science to be socially responsible by delivering what society needs and values when one cannot predict what science will deliver? And even if one could predict the outputs and consequences of scientific inquiry, one may not be able to anticipate their acceptance by society. Moreover, one cannot always predict what society needs to know, sometimes urgently, as the Covid-19 crisis has reminded us vividly.[16]

One needs first to distinguish between two kinds of unpredictability in science (Bedessem and Ruphy 2019). 'Unpredictability' may sometimes refer to unforeseen practical applications of fundamental knowledge. The laser is a paradigmatic case of this first type of unpredictability: the development of this technological device in early 1960s (Maiman 1960) was evidently not foreseen as an application of the theoretical developments of quantum mechanics that took place decades before. A second type of scientific unpredictability concerns the occurrence of unexpected results or observations in the course of scientific inquiry, leading to the opening of new lines of research and discoveries. A paradigmatic case of this kind of unpredictability is the famous accidental observation by Alexander Fleming of the blocking effect of a fungus on the proliferation of bacterial colonies (Fleming 1929) that led to the development of antibiotics.

My point here is about the first type of scientific unpredictability: should we value the prospects of unforeseen applications as paramount when facing specific, pressing, urgent or otherwise important social or societal issues, the resolution of which could be facilitated by science? Taking seriously humanist expectations of science invites, I suggest, a negative answer. Once the shift toward more pressing and more targeted expectations is deemed legitimate – and recall that this is, I contend, a political issue – research oversight policies should favour research programs mainly oriented by exogenous problems, aiming at responding to identified needs. If we already know that we urgently need better energy storage devices (etc.), why should we still place so much value on the hypothetical development of the next laser decades down the line? Laser-type unpredictable outputs may remain preeminently valuable so long as long term contributions to economic growth and competitiveness are viewed as the central expectation for science, that is, when one mainly

[16] There are many examples beyond the Covid case. Consider for instance the pressing need for knowledge about radicalization processes when a country faces terrorist attacks.

expects from science breakthrough innovations that open new markets. But a properly functioning democracy may (hopefully) broaden and diversify its expectations for science and opt for, if needed at a certain time, more targeted and short term expectations (e.g., focusing on health, environmental, and strategic independence issues), making laser-type unpredictability a less valuable feature of science. As the British scientist and political activist J. D Bernal put it some time ago, “Although it is true that we do not know what we may find, we must, in the first place, know where to look” (1939).

It thus turns out that the humanist aim of reducing the gap between what society needs and the outputs of scientific inquiry requires us to downplay the value of scientific unpredictability (as unforeseen applications). Here again, this calls for a significant cultural change for both many practising scientists and much of the rest of society.

*Loss of autonomy*

A third interesting and common reason to resist a growing demand for accountability in the sense of direct social utility is to invoke some putative negative epistemological effects of a loss of scientific autonomy when it comes to the choice of research questions.[17] In a nutshell, the argument put forward by proponents of autonomy is that the shaping of the research agenda by exogeneous issues hampers the epistemic fecundity of science. In other words, or so the “unpredictability argument” goes, research whose agenda is set according to external considerations is less hospitable to the flourishing of the unexpected in inquiry, hence less fecund, than research whose agenda is freely set internally by scientists following their curiosity and favoring the resolution of endogenous problems. A well known and somewhat lyrical formulation of the unpredictability argument is given by Polanyi in his classic essay “The Republic of Science” (1962, p. 62): “Any attempt at guiding research towards a purpose other than its own is an attempt to deflect it from the advancement of science. (…) you can kill or mutilate the advance of science, you cannot shape it. For it can advance only by essentially unpredictable steps pursuing problems of its own and the practical benefits of these advances will be incidental and hence doubly unpredictable”. I will not come back here to the issue of

[17] I will not comment here the very human reluctance to give up or share power as grounds for resisting more accountability, since this is not specific to *science* decision makers.

the desirability of unpredictable applications, but instead focus on the second type of unpredictability: occurrences of the unexpected in the course of scientific inquiry.

I have argued elsewhere that the unpredictability argument has many weaknesses. It is hardly convincing as a defense of the autonomy of science and the pressure of exogenous problems may actually favor the occurrence of the unexpected (Bedessem and Ruphy 2019). Leaving these contentions aside here, however, even if the unpredictability argument were to hold as an argument supporting the choice of endogenous problems, the question would arise again: should epistemological considerations prevail over all others? After all, one might very well choose to prioritize the resolution of urgent or pressing (social or societal) problems at the possible cost of some (temporary) loss of epistemic fecundity.[18] And again, this should be a matter of *political* choice.

**7. Conclusion**

Humanist commitments regarding science in terms of relevance and benefits for society operate at two different levels, local and global, each raising specific challenges. In this chapter, I first discussed various ways in which lay citizens may engage in the very process of producing knowledge and expertise, alongside with professional scientists, and spelled out how public engagement at local scales may allow us to reduce the gap between science's outputs and society's needs. Three main, interrelated challenges were identified: (i) the need for more incentives from scientific institutions and communities to engage in citizen science programs; (ii) the need for an evolution of the professional training of scientists and of cultural views on what kinds of science are worth pursuing; (iii) the need for an increase in individual awareness of the existence of political and ethical choices to be made as regards the type of research one is willing to engage in as an individual researcher.

When tantamount to accompanying stakeholders, the humanist commitment may appear on the face of it rather modest. However, it turns out to be very demanding in our inegalitarian democracies. For a humanist commitment regarding science requires us to ensure that *all* citizens and groups of citizens are afforded the chance to become epistemically

[18] Note that such political choices have been made in the past. Just think about the Manhattan project channeling research efforts toward well-defined practical ends.

well-equipped stakeholders and to assert their interests in the political arena. It is, admittedly, not solely the responsibility of scientists and science decision makers to ensure that the voices of all citizens are heard in a democracy. However, heightening vigilance within science so that the epistemic needs of underrepresented groups don't remain below the radar of scientific research because of unbalanced distributions of power in society at large is certainly called for.

At the more global scale of setting big research priorities, we have seen that calling for more relevance and benefits for *all* members of society impacts scientific life in several fundamental ways. It raises first the question of the legitimacy and desirability of a shift towards more targeted and pressing expectations concerning scientific research. Here the contribution of philosophy is to assess the very nature of the question and to argue (in my case) that it should be considered, in contemporary democracies, a *political* question. It also challenges the valuation of culturally well-entrenched features of science such as the valuation of unpredictability (as unforeseen applications). A complementary task is then to explore further the epistemological consequences of this shift for the dynamics of research fields, to identify epistemologically acceptable forms of limitation of scientific autonomy, and possibly to debunk other unfounded sources of resistance.

Another major philosophical task is to continue to explore the practical forms that a democratization of the setting of research agendas may take. It is difficult today to argue against the idea that citizens should have a say in the matter, but how exactly should that be accomplished? How should we articulate, for instance, the requirements of direct participation and indirect participation (via elected representatives)? To what extent is the implementation of participatory strategies at national scales compatible with the internationalization of science? These are undoubtedly crucial challenges to be met on the way to a more humanist science.

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